Monitoring of off-site wetland mitigation at the Olentangy River Wetland Research Park for Spring-Sandusky Interchange—2005

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Introduction

This report represents the fifth-year mitigation report for the project "*Wetland Monitoring and Management Plan for Off-Site Wetland Mitigation for Spring-Sandusky Interchange*" contracted between The Ohio State University and the Ohio Department of Transportation (ODOT). The restoration is being carried out as part of the mitigation for the Spring-Sandusky interchange project in downtown Columbus. The bottomland hardwood forest is part of the 30-acre Olentangy River Wetland Research Park (ORWRP) at The Ohio State University (Fig. 1). This report covers the period October 1, 2004 - September 30, 2005.

Site Restoration

Restoration/enhancement of this 13-acre bottomland forest involves two major management approaches:

Hydrologic restoration

Four 20-ft wide breeches were made in an artificial levee that runs most of the northern half length of the 13-acre bottomland forest along the Olentangy River at the ORWRP. The levee had been constructed to prevent floodwater from reaching the floodplain perhaps as long as 100 years ago. In June 2000 and again in April 2001, the levee was breached in 4 locations to allow floodwater to enter the site. Locations of levee cuts and general elevations of the bottomland forest are shown in Fig. 2. Restored hydrology is expected to increase long-term productivity of canopy trees in the forest and may result in some species shifts to more flood-tolerant species. The increased flooding is also expected to bring in nutrients with sediment input and plant propagules with flowing water, both of which will lead to enhanced forest productivity and biodiversity. It is also expected that the shifting sediments caused by more frequent surface flooding will change the understory and eventually the sub-canopy vegetation to a more natural condition typical of bottomland hardwood forests.

Removal of alien honeysuckle

In addition to the hydrologic modification, a program of invasive plant removal has been initiated, with a design so that researach can be done as to its effectiveness. The major invasive plant species that has been removed from the forest in several locations on several occasions is the Amur honeysuckle (*Lonicera maackii* Maxim.). Table 1 provides a summary of all honeysuckle removal episodes that have occurred at the bottomland in the past 5 years. In the past 5 years, honeysuckle removal projects were regularly conducted using volunteer groups, in collaboration with the ORWRP, ODOT, FLOW (Friends of Lower Olentangy Watershed) and the City of Columbus. The removal of honeysuckle is expected to allow the bottomland subcanopy to become more diverse as its dense biomass is removed. Our observations after skipping only one year is that honeysuckle is making a significant recovery in areas that were harvested on several occasions 2001-05, suggesting that an annual honeysuckle removal program is required for it to be successful. The program that we established is based on volunteering of time and material by individuals and many organizations.

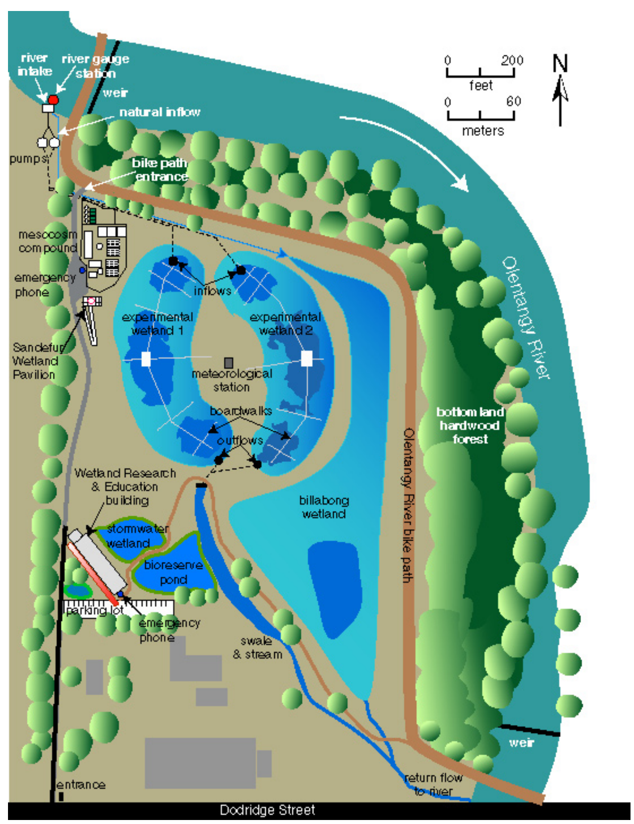

Figure 1. Master map for the Olentangy River Wetland Research Park at The Ohio State University. The bottomland hardwood forest is shown along the northern and eastern edges of the research park.

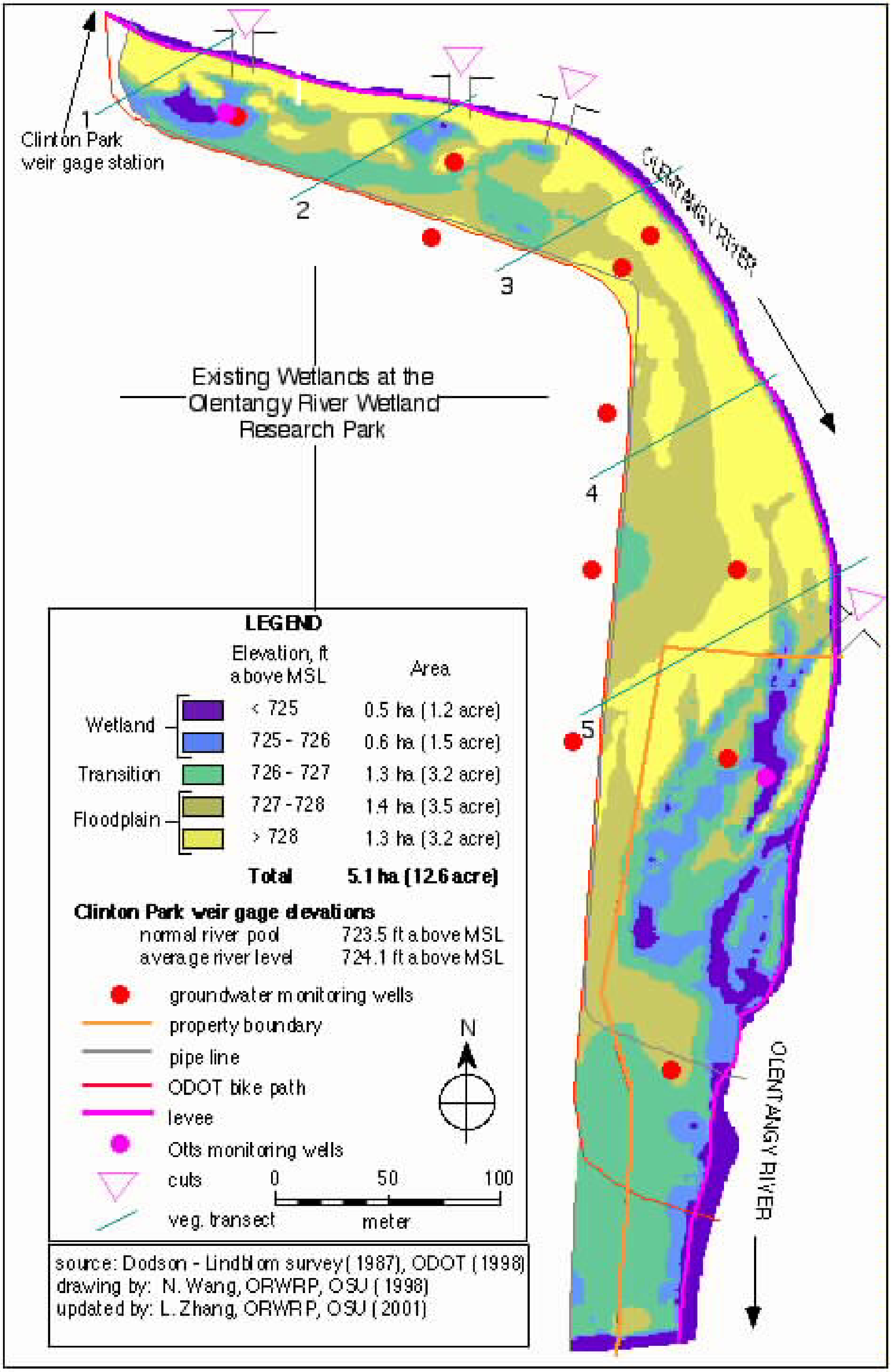

Figure 2. The 13-acre bottomland forest monitoring area, indicating land elevations, monitoring wells, and 4 locations ("cuts") where artificial levee was breached to allow bottomland flooding.

Figure 3. Aerial photo in August, 2005, for bottomland forest and Olentangy River Wetland Research Park. Vegetation shows no permanent scars in forest canopy from the cuts. Note macrodetritus in river from Cut #1.

Table 1. Dates of honeysuckle removal in the bottomland hardwood forest at the Olentangy River Wetland Research Park since 2001

Date		Location of activity	Herbicide?	Group Est. man-hrs
September 18, 2001	FLOW/OSU volunteer group	northern one-fifth	yes	100
October 18, 2001	Franklin Heights/FLOW volunteers	northern one-third	no	30
May 3, 2002	OSU/ORWRP Wetland Day	northern one-third	yes	60
April 12, 2003	OSU/ORWRP Planting Day	northern one-fifth	yes	100
September 23, 2003	FLOW/OSU volunteer group	northern one-third	yes	60
October 11, 2003	FLOW volunteer group	northern one-third	yes	60
September, 2005	City of Columbus	bikepath edges	yes	50

Figure 4. Photos taken on January 13, 2005 of bottomland hardwood forest area and Olentangy River during flooding event

Figure 5. Photos taken on January 13, 2005 of bottomland hardwood forest during flooding event top: inflow at cut #1; bottom: bottomland adjacent to cut #1.

Table 2. Floods of bottomland hardwood forest since beginning of the mitigation monitoring of this bottomland hardwood forest in January 2001.

Date	Peak river stage, ft
WATER YEAR 2001	
April 11, 2001	16.15
WATER YEAR 2002	
December 2, 2001	16.74
December 18, 2001	17.87
February 3, 2002	16.91
April 5, 2002	16.88
April 14-18, 2002	17.88
May 17, 2002	
WATER YEAR 2003	16.99
March 5-14, 2003	16.85
April 8, 2003	16.61
May 12-16,2003	18.22
June 14, 2003	17.77
July 13, 2003	16.23
August 30,2003	16.93
September 30, 2003	17.08
WATER YEAR 2004	
Decemebr 1, 2003	16.89
January 4, 2004	19.21
March 22, 2004	16.99
April 2, 2004	16.88
May 4, 2004	17.17
May 21, 2004	18.21
June 2, 2004	17.90
June 14, 2004	20.22
June 20, 2004	17.79
WATER YEAR 2005	
January 6, 2005	19.75
January 12, 2005	19.87
February 10, 2005	17.74
March 28, 2005	17.85
April 5, 2005	17.41
April 27, 2005,	18.68
May 19, 2005	17.25
June 30, 2005	16.14
July 16, 2005	16.41
August 3, 2005	16.77

Aerial Photographs for 2005

Aerial photography of the bottomland forest is obtained annually from ODOT low altitude remote sensing. The aerial photo for August, 2005 is shown in Figure 3. No winter photography was obtained in 2005. Summer 2005 photography shows a fully developed canopy with no indications of any permanent gaps in the canopy caused by the breeches.

Hydrology

A stream gauging station with an Ott Thalimedes water level recoreder and data logger and water quality probe was installed on the Olentangy River in June 2001 and a 30-min interval reading was established for downloading data (see "Clinton Park weir gage station in Fig. 2). Two water level stations with Ott Thalimedes data loggers were installed at upstream and downstream sites in the bottomland forest in December 2000 (see "Ott monitoring wells" in Fig. 2) with 30-min interval readings. Recording started February 2001. One Ott recorder is located near the 1st cut in the levee and is referred to as "upstream" site. The 2nd Ott is located downstream of the 4th and last cut and is referred to as the "downstream" site.

Ten major independent flooding events occured in the 2005 water year (Oct 1, 2004 - Sept 30, 2005) with sufficient stage to flood the bottomland forest through the levee breeches (Table 2 and Figures 4-6). In the five years of monitoring the river since the cuts were made in the levee, 33 flooding events have occurred. This is a rate of approximately 6 flood events per year, the rate that was predicted when the mitigation was designed in 1998-99. Water level records for periods of available data in the 2005 water year from the upstream groundwater recorder in the bottomland forest (Figure 7) shown that substantial and sustained flooding occurred in the bottomland hardwood forest by the Olentangy River in the period January to July 2005. There were even small pulses in the usually low-water period of August and September 2005. The downstream water level data logger was harmed by a particularly high river flood in 2003 and was not operating in 2005. Both water level recorders were reinstalled in fall 2003 to elevations well above any expected flood stage to avoid future damage to instrumentation.

Water Quality

Figures 8 and 9 show river stage and water quality in the Olentangy River during flooding events in April and May 2005. Flooding generally caused decreases in dissolved materials (see conductivity) and dampened diurnal patterns of temperature, dissolved oxygen, and pH, indicating the effects of floods on changing in-stream productivity. Although turbidity data are not shown here, there are often significant increases in turbidity (suspended sediments) immediately before and during bottomland flooding, maximizing sediment transport into the bottomland forest. This increased sediment input yields incresased nutrient input which will likely contribute in the long term to enhanced forest productivity.

Sedimentation

A sedimentation study was conducted in 2003, 2004 and 2005 in the bottomland hardwood forest and data were analyzed in 2005 (see attached report by Zhang et al., p. 11). Sediment samples were captured for 1 flooding events that occurred in 2005. Sedimentation in the wettest areas averaged 147±47 g-dry wt/m^2. Sedimentation data were used to estimate sedimentation contribution of carbon and

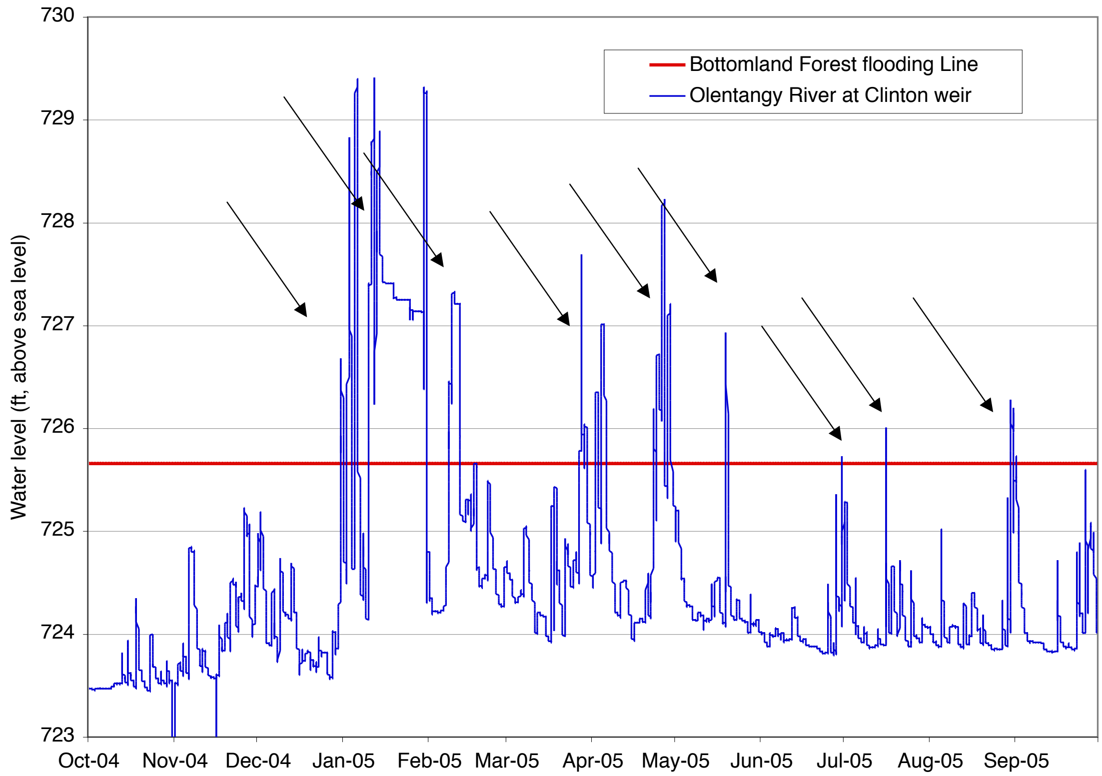

Figure 6. Hydroperiod for Olentangy River at ORWRP for 2005. Arrows indicate flood peaks that occurred in 2005 water year in the bottomland hardwood forest. Flooding line indicates approximate elevation of floodplain at which the river floods the bottomland.

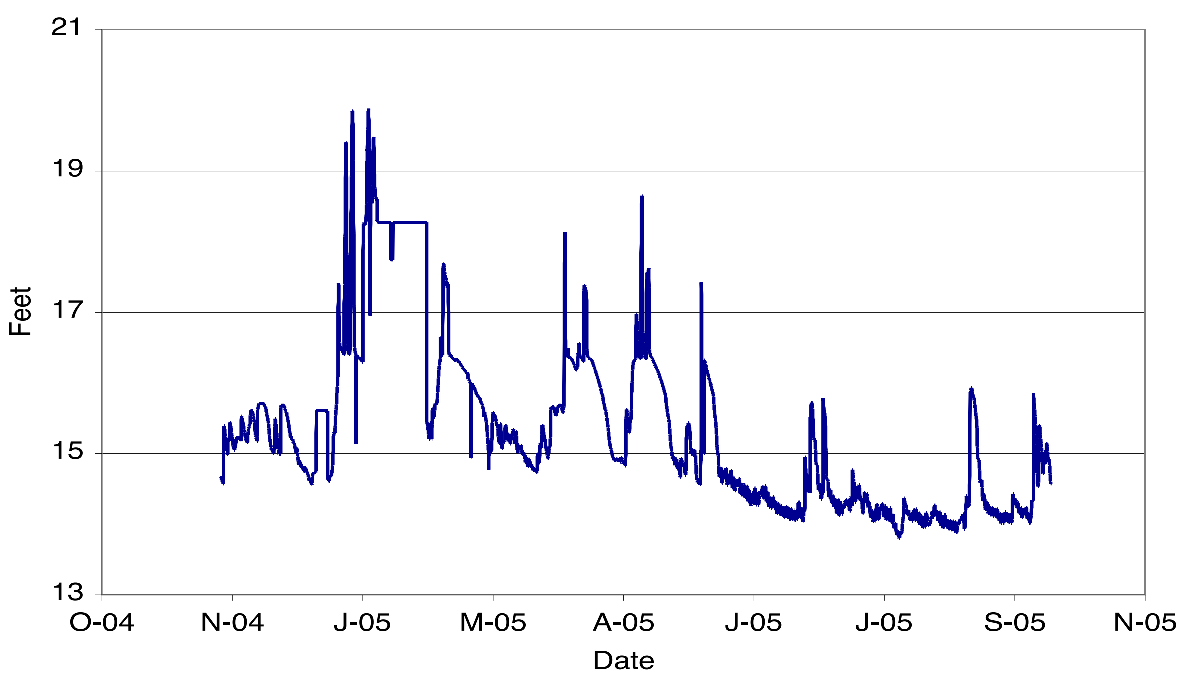

Figure 7. Upstream groundwater monitoring well in bottomland hardwood forest in 2005 of the water year Water level peaks correspond to river flooding.

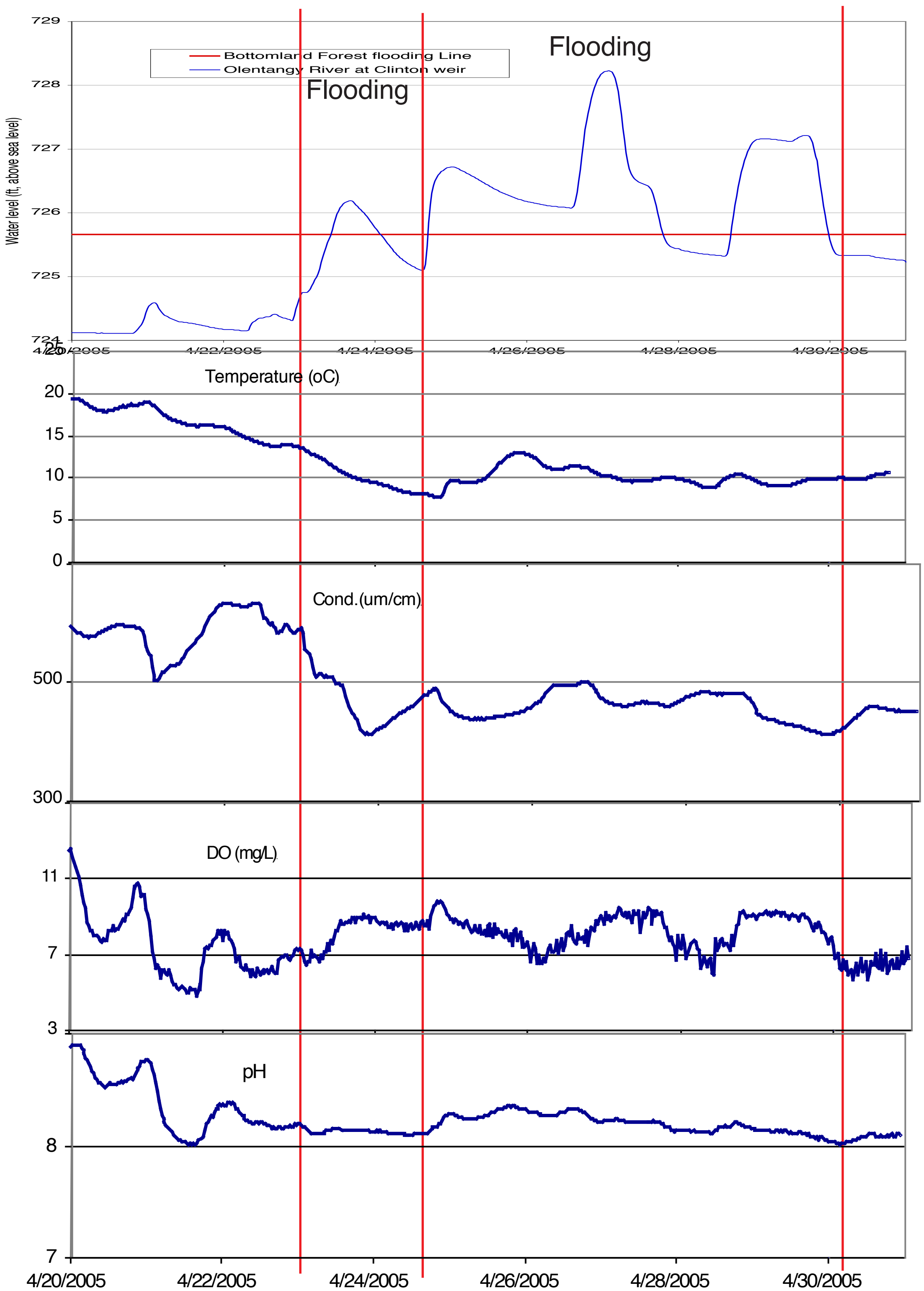

Figure 8. River stage and water quality of the Olentangy River at the Clinton Park weir for April 2005. Two major flood events occured during this period and are highlighted.

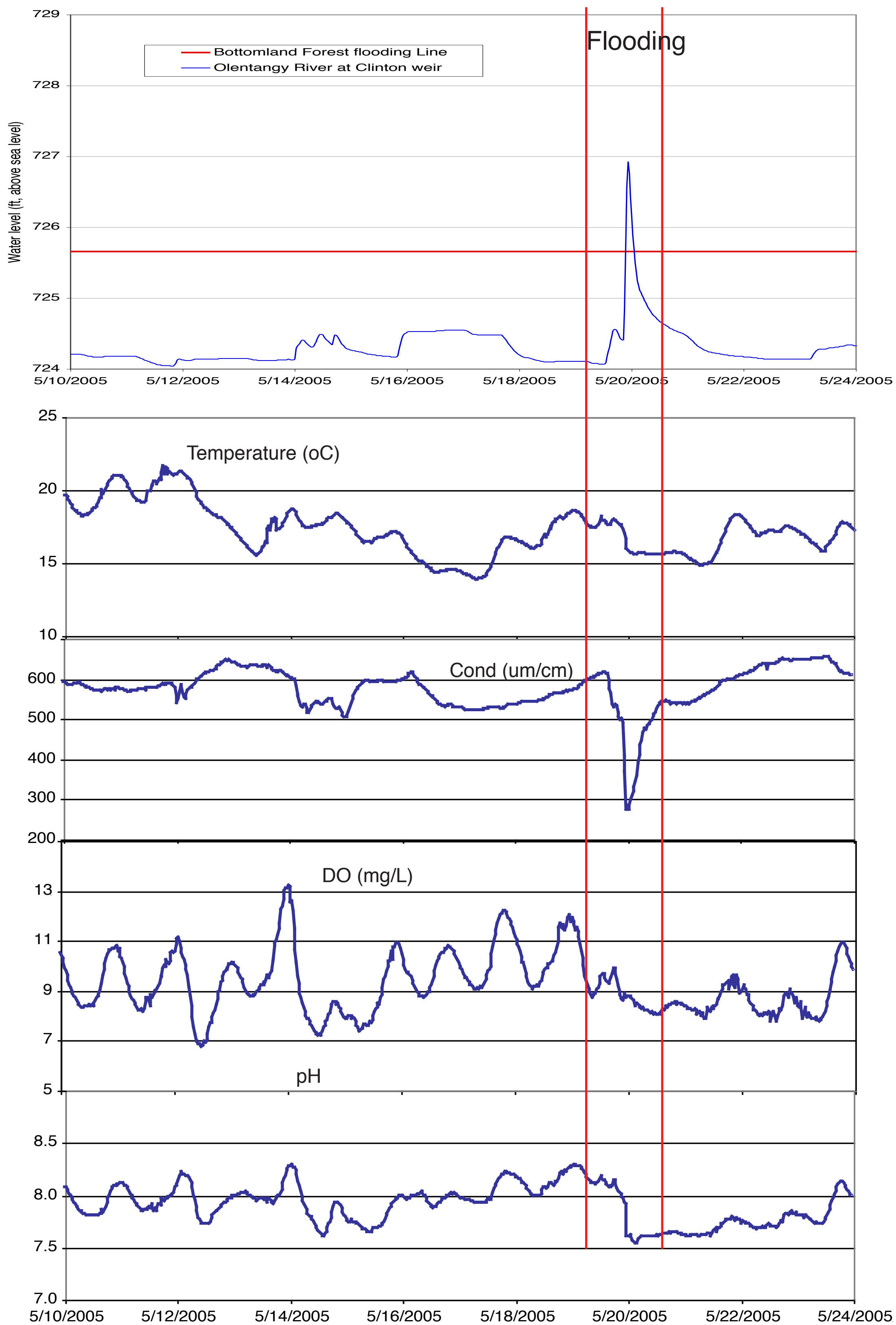

Figure 9. River stage and water quality of the Olentangy River at the Clinton Park weir for May 2005. The flood event occured during this period and are highlighted.

nitrogen to the bottomland hardwood forest by the river.

Forest Canopy

Ten 20 x 25 m (500 m^2) plots were established in the bottomland forest in April 2003 for vegetation productivity estimations (see Anderson and Mitsch, 2004). Four of the plots are in the northern half of the bottomland forest where the levee was breeched. Six plots were in the southern half of the bottomland where flooding has normally occurred. All trees >5 cm dbh within these plots were identified in April 2004. Mean tree density was 40 ± 7 trees per plot. Tree density was higher in the northern section of the forest (62.8 ±7.2 trees per plot) compared to the southern section (24.8 ±3.7 trees per plot). Tree species with the highest relative densities were box elder (*Acer negundo*), Ohio buckeye (*Aesculus glabra*) and pawpaw (*Asimina triloba*). All three species occurred in the subcanopy. Canopy trees were dominated by American sycamore (*Platanus occidentalis*), Eastern cottonwood (*Populus deltoides*), hackberry (*Celtis occidentalis*) and osage-orange (*Maclura pomifera*). While most of the tree species are facultative (FAC) and adapted to drier conditions, we continue to believe that in the long run (>50 years) the canopy will change to reflect wetter conditions as a result of the hydrologic restoration. Aerial photography from August 2005 (Fig. 3) shows a healthy canopy with no obvious gaps that would be caused by dying trees. One development that has affected forest canopy in the past year is the increased deterioation of the existing levee along the north section of the bottomland. This has been caused by ongoing scouring along the levee-river interface, particularly during high water events. As a result, a few of the sizeable trees growing on the levee fell into the river in 2005. The fallen trees uprooted which lead to further deterioation of the berm. We expect this trend to continue and consider it a positive development as it will increase exposure of the bottomland to periodic flooding.

Net aboveground primary productivity (NAPP) in the bottomland forest for the months June through October 2004 was 450±6 g-dry wt m^{-2} for the north section that was restored and 467±30 g-dry wt m^{-2} for the south section that had continuous flooding and was not as significantly impacted by the restoration. Rates were not significantly different. Productivity results in 2005 are given in Anderson and Mitsch, attached, p. 17).

No abrupt and clear changes in canopy tree basal growth has occurred since the hydrologic restoration started in 2000; however since 2003, trees in the south section of the bottomland have shifted from a continuous trend of declining basal area increment (BAI) that extended back about ten years. Our results also suggest that tree basal growth in response to flooding is lagged by at least one year as no relationships were detected between tree basal growth and concurrent flooding over one year. The lack of any significant relationship between tree basal growth and flooding in the growing season suggests that stimulation of productivity by sediment and nutrient deposition is likely more important to forest productivity than any stress caused through flooding.

Fifth year review

A fifth year site visit was completed in September 2005. Agencies that reviewed the site included the OEPA, USACE, ODNR, and the USFWS. All of the parties in attendance concurred that the out of kind mitigation, bottom land forest restoration, is developing expected functions and values, and had no comments suggesting modification or alteration of the current mitigation design.

Publications and Presentations

The following publications and presentations resulted from this mitigation project.

Anderson, C.J. 2005. The influence of hydrology and time on productivity and soil development of created and restored wetlands. Ph.D. Dissertation, School of Environment and Natural Resources, The Ohio State University.

Swab, R. 2005. Effectiveness of Lonicera maackii removal from a bottomland hardwood forest in central Ohio. Master's thesis, School of Natural Resources, The Ohio State University.

Swab, R. and W.J. Mitsch. 2005. Effectiveness of *Lonicera maackii* removal from a bottomland hardwood forest in Central Ohio. Abstracts, American Ecological Engineering Society (AEES) 5th Annual Meeting, May 18-19, 2005, Columbus, OH

Swab, R. and W.J. Mitsch. 2005. Effectiveness of *Lonicera maackii* removal from a bottomland hardwood forest in Central Ohio. Abstracts, Society of Wetland Scientists 26th Annual Meeting, Charleston, SC

Zhang, L., W. J. Mitsch, V, Bouchard and K, Hossler. 2005. Sediment chemistry in a hydrologically restored bottomland hardwood forest in Midwestern US. Abstracts, American Ecological Engineering Society (AEES) 5th Annual Meeting, May 18-19, 2005, Columbus, OH